

CLAIMS

1. A substrate material for X-ray optical components for X-rays of wavelength λ_R , comprising a glass ceramic material with a glass phase made of amorphous material and a crystal phase, comprising microcrystallites, with the amorphous material having a positive thermal expansion and the microcrystallites having a negative thermal expansion and the stoichiometric ratio of crystal to glass phase being set in such a way that the amount of the thermal expansion α of the glass ceramic material is in a temperature range of 20°C to 100°C $< 5 \times 10^{-6} \text{ K}^{-1}$, especially $< 1 \times 10^{-6} \text{ K}^{-1}$, with the mean size of the microcrystallites being $< 4 \lambda_R$, especially $< 2 \lambda_R$, preferably $< \lambda_R$, more preferably $< 2/3 \lambda_R$, especially $< \lambda_R/2$, characterized in that the substrate material, following a surface treatment, shows a roughness in the high spatial frequency (HSFR) region of $< \lambda_R/30 \text{ rms}$, preferably $< \lambda_R/50 \text{ rms}$, especially preferably $< \lambda_R/100 \text{ rms}$.
2. A substrate material as claimed in claim 1, characterized in that the wavelength of the X-rays is in the range of λ_R of 10 to 30 nm.
3. A substrate material as claimed in one of the claims 1 to 2, characterized in that after a surface treatment the defect in the low spatial frequency region is in the range of $\lambda_R/50$ to $\lambda_R/100 \text{ rms}$.
4. A substrate material as claimed in one of the claims 1 to 3, characterized in that after a surface treatment the defect in the middle spatial frequency region (MSFR) is in the range of $\lambda_R/50$ to $\lambda_R/100 \text{ rms}$.
5. A substrate material as claimed in one of the claims 1 to 4, characterized in that in the surface treatment of the substrate

material the surface of the X-ray optical component is superpolished at first and thereafter the surface is further processed by a beam processing method.

- 5 6. A substrate material as claimed in one of the claims 1 to 5,
characterized in that the substrate material is a substrate material
for a reticle mask for EUV lithography.
- 10 7. A substrate material as claimed in one of the claims 1 to 5,
characterized in that the substrate material is a substrate material
for a normal-incidence mirror, with a multilayer system with a
plurality of layers with high reflectivity in the X-ray range in the case
of non-grazing incidence being applied onto the substrate material.
- 15 8. A substrate material as claimed in claim 7, characterized in that the
mirror has an aspherical shape.
- 20 9. A substrate material as claimed in claim 7 or 8, characterized in that
to the substrate material there is applied a multilayer system
comprising 40 to 200 layer pairs consisting of one of the following
materials:
Mo/Si
Mo/Bi
MoRu/Be.
- 25 10. An X-ray optical component, characterized in that it comprises a
substrate material according to one of the claims 1 to 9.
- 30 11. An X-ray optical component as claimed in claim 10, characterized in
that the X-ray optical component is a normal-incidence mirror or a
grazing-incidence mirror.

12. An X-ray optical component as claimed in claim 10, characterized in that the X-ray optical component is a reticle mask.
13. A method for producing a substrate material for an X-ray optical component for X-rays of wavelength λ_R , with the substrate material being a glass ceramic material and the method comprising the following steps:
- 13.1 surface of the substrate material is superpolished until a high spatial frequency roughness (HSFR) of $< \lambda_R/30$ rms, preferably $< \lambda_R/50$ rms, even more preferably $< \lambda_R/100$ rms, is achieved;
- 13.2 the surface is further processed with a beam processing method until the defect in the low spatial frequency region is $\lambda_R/50 - \lambda_R/100$ rms and the defect in the middle spatial frequency region (MSFR) is $\lambda_R/50 - \lambda_R/100$ rms, with the high spatial frequency roughness (HSFR) obtained being $< \lambda_R/30$ rms, preferably $< \lambda_R/50$ rms, even more preferably $< \lambda_R/100$ rms.
14. The use of a substrate material for X-ray optical components as claimed in one of the claims 1 to 9 in an EUV projection system, comprising an illumination system and a projection lens system.
15. The use of a substrate material for X-ray optical components as claimed in one of the claims 1 to 9 in one of the following fields:
X-ray microscopy;
X-ray astronomy;
X-ray spectroscopy.